

# $D_s$ production cross section

Reinhard Schwienhorst  
University of Minnesota

E872 phone meeting, long report, 2/19/99

# Purpose and Goal

- Find the number of tau neutrinos produced in the beam dump
- $D_s$  decays are the dominant source of tau neutrinos.
- Find the number of  $D_s$  produced in the beam dump

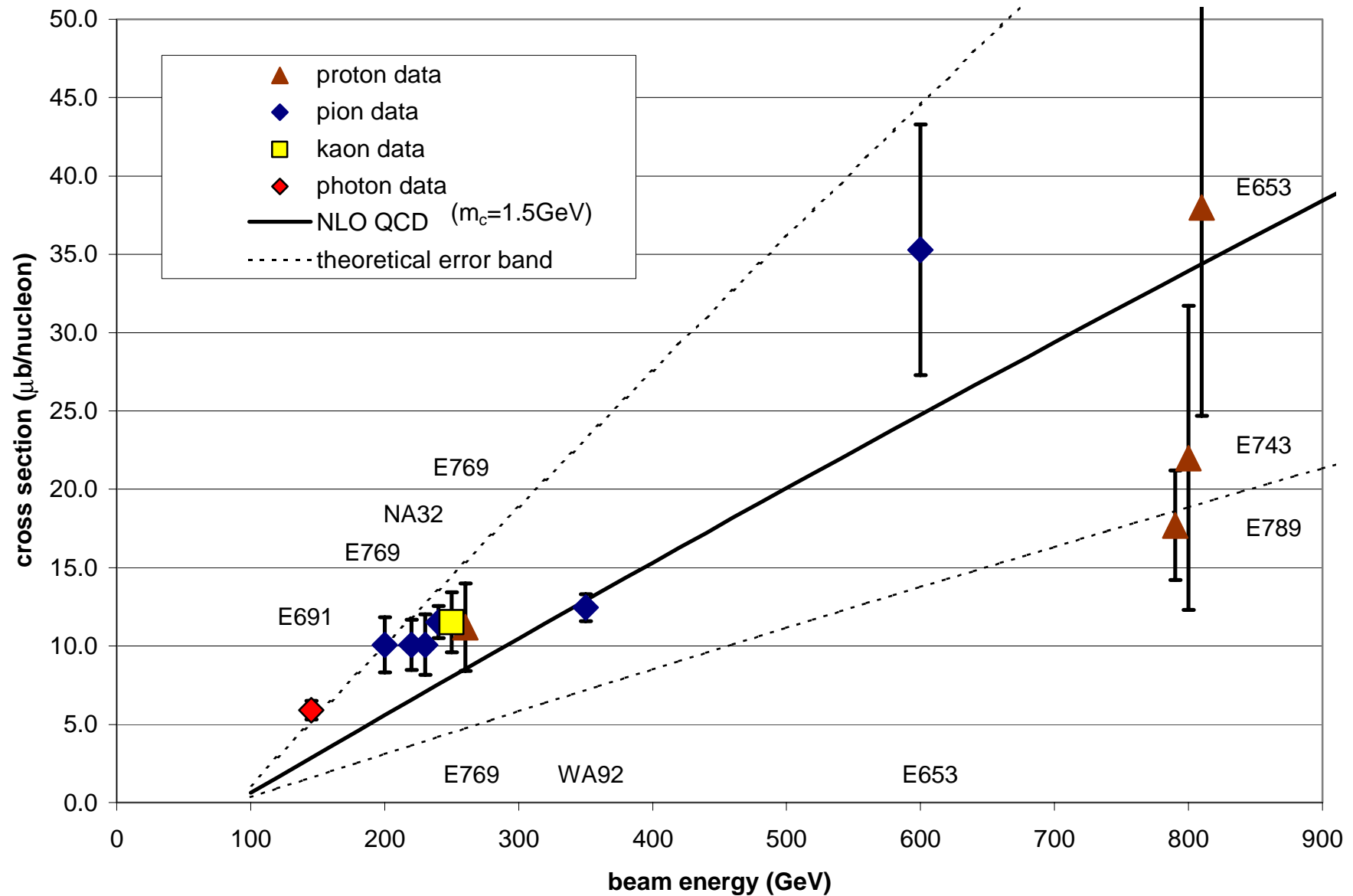
# Method 1

- Measurements of the  $D_s$  production cross section:
  - none exist for a beam energy of 800GeV
  - find measurements for other energies  
E769: 250GeV,  $\sigma_{D_s}=1.5\pm1\mu\text{b}$
  - use a theoretical curve to project them to an energy of 800GeV  
(NLO QCD calculation for  $D^\pm$ )

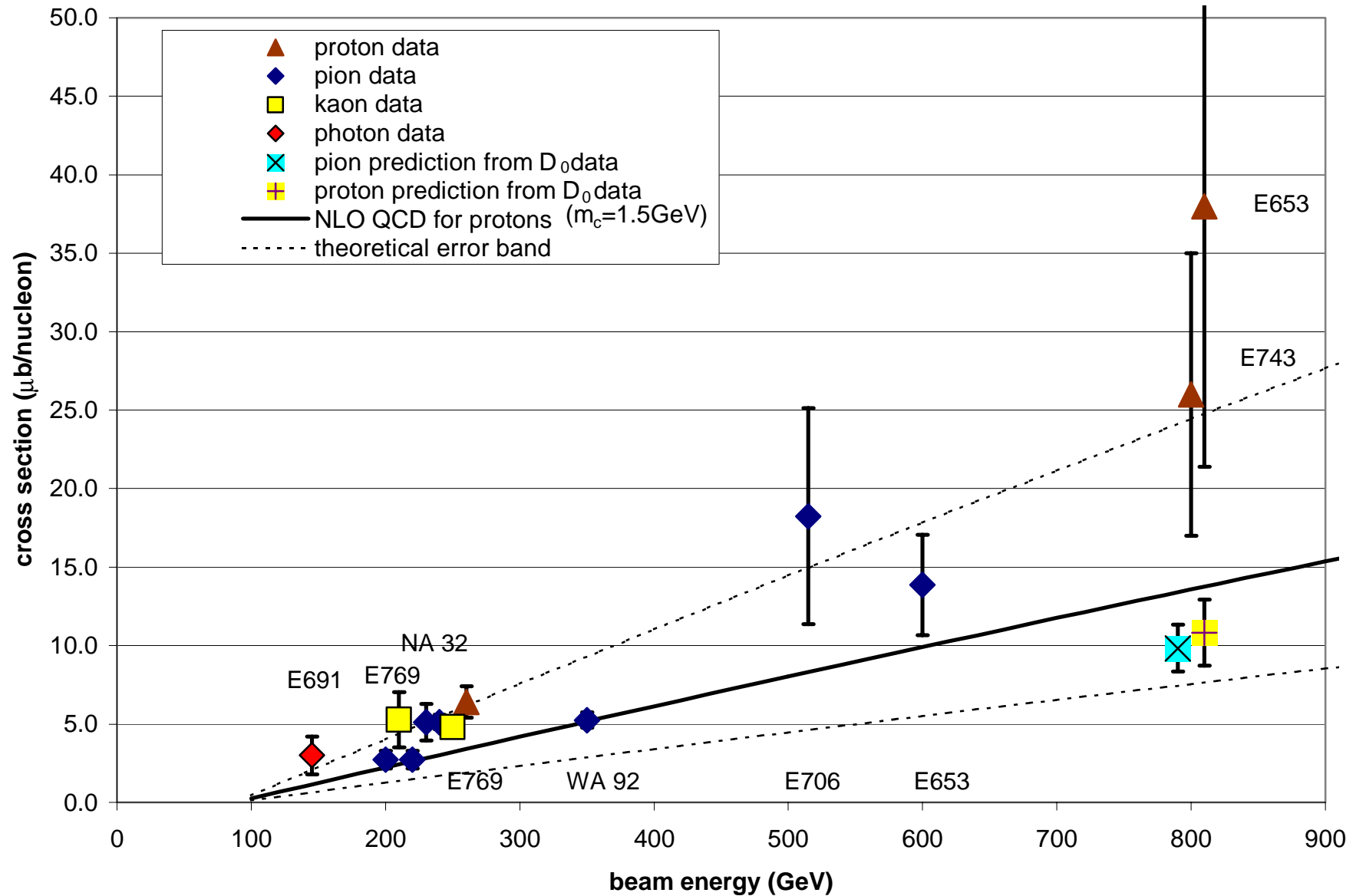
# Method 2

- Find measurements of the production cross section for  $D^\pm$  and  $D^0$ .
- Find the cross section ratio
  - $D_s/D^\pm$  and  $D_s/D^0$ .
- Compute the production cross section for  $D_s$ .

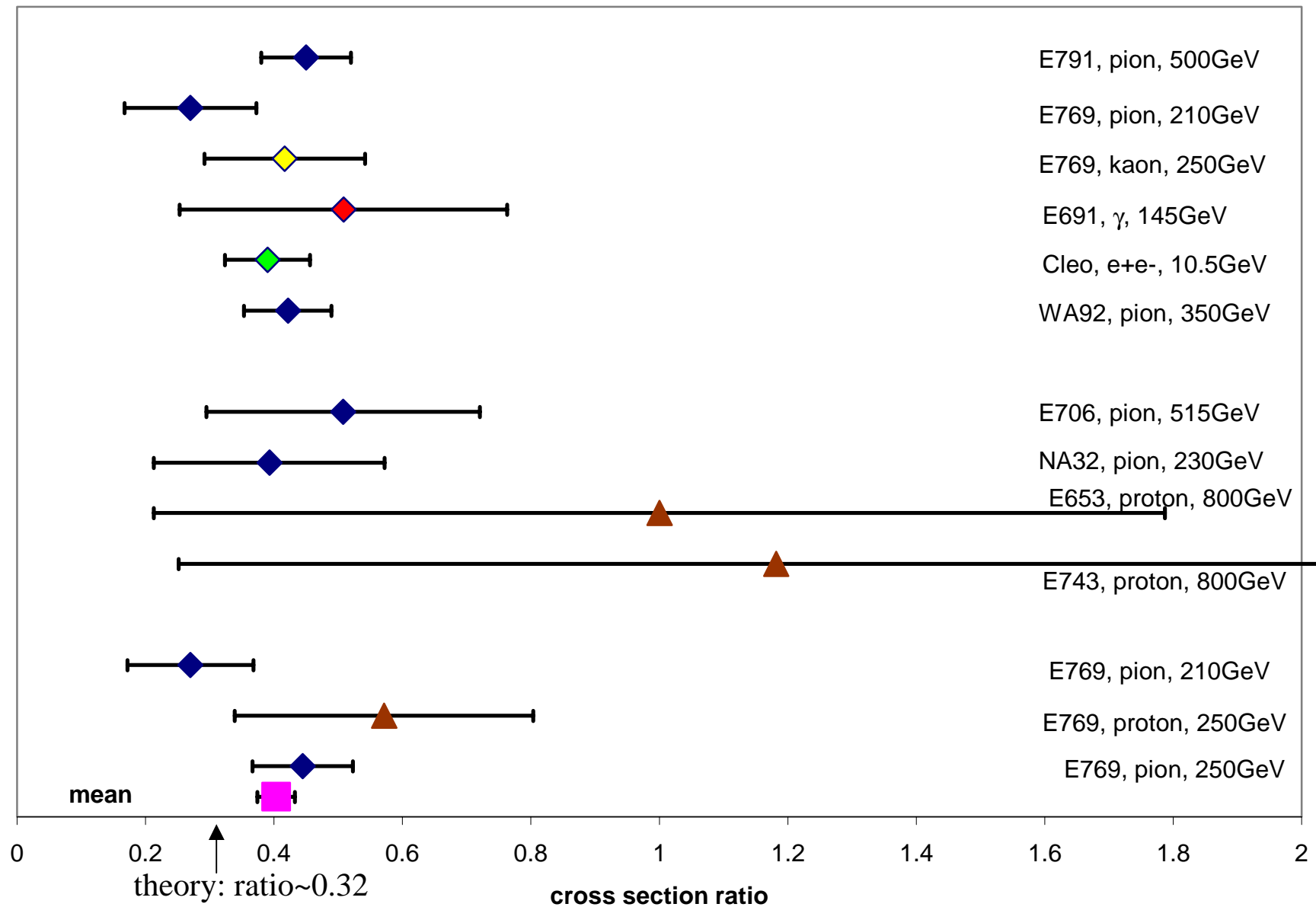
# $D^0$ production cross section for pions and protons in fixed target experiments



# $D^\pm$ production cross section for pions and protons in fixed target experiments



# Ratio of $D^\pm$ over $D^0$ production cross sections



# Theoretical prediction of the $D^\pm$ over $D^0$ production cross section ratio

Assumption: all D meson states are created with equal probability

Isospin considerations:

- Isoscalar:  $D^\pm$  and  $D^0$
- Isovector:  $D_{\pm}^*$  and  $D_0^*$

Branching ratios:

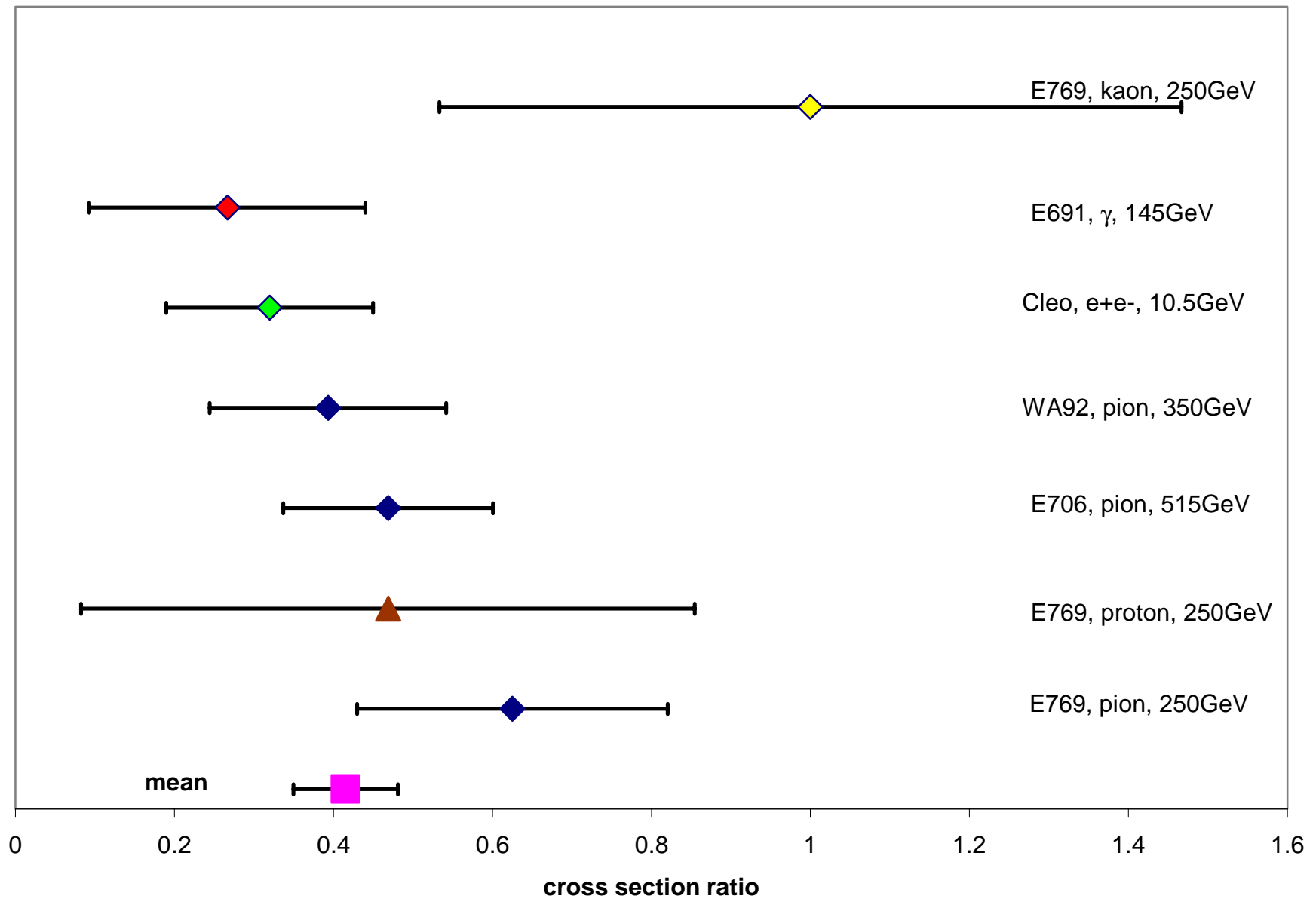
- $D_{\pm}^* \rightarrow D^\pm$  Br=30.6%,  $D_{\pm}^* \rightarrow D^0$  Br=68.3%
- $D_0^* \rightarrow D^0$  Br=100%

Count particles:

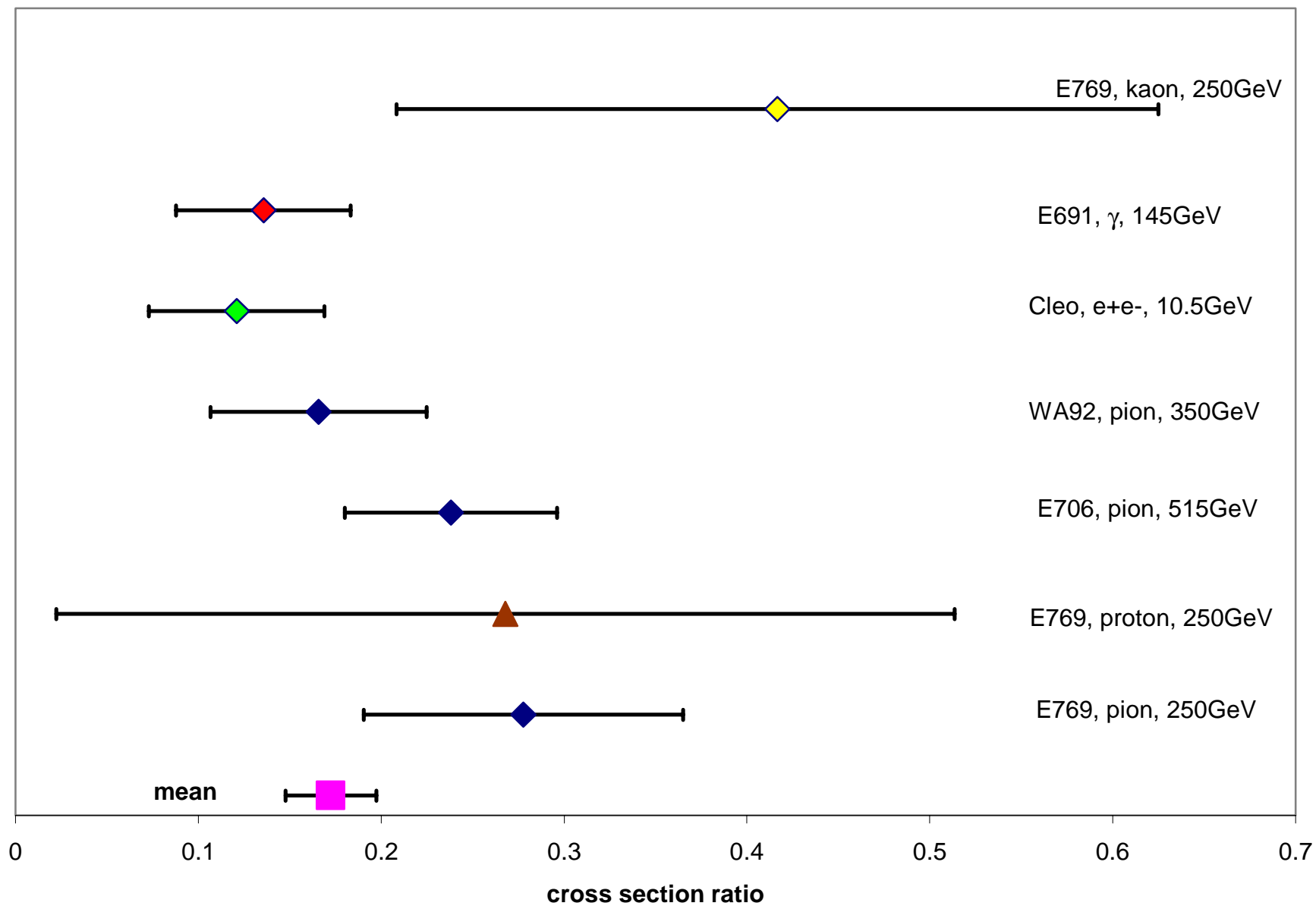
- for every 8 charm quarks:
  - originally produce 1  $D^\pm$  , 1  $D^0$  , 3  $D_{\pm}^*$  ,  $D_0^*$
  - after decay of the resonance:

$$2.56 D^\pm , 5.44 D^0 , \text{ratio}=0.32$$

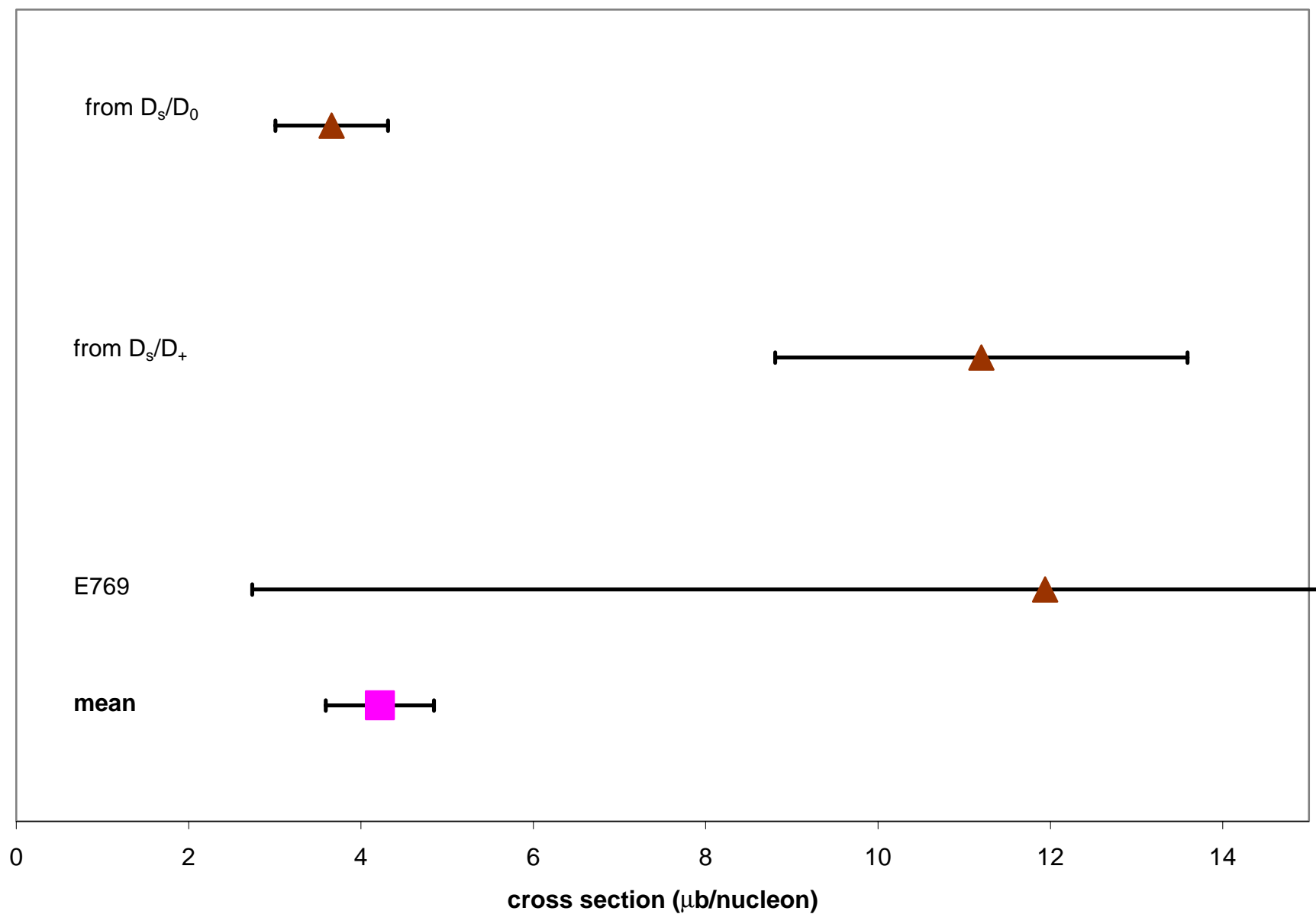
# Ratio of $D_s$ over $D^\pm$ production cross sections



# Ratio of $D_s$ over $D^0$ production cross sections



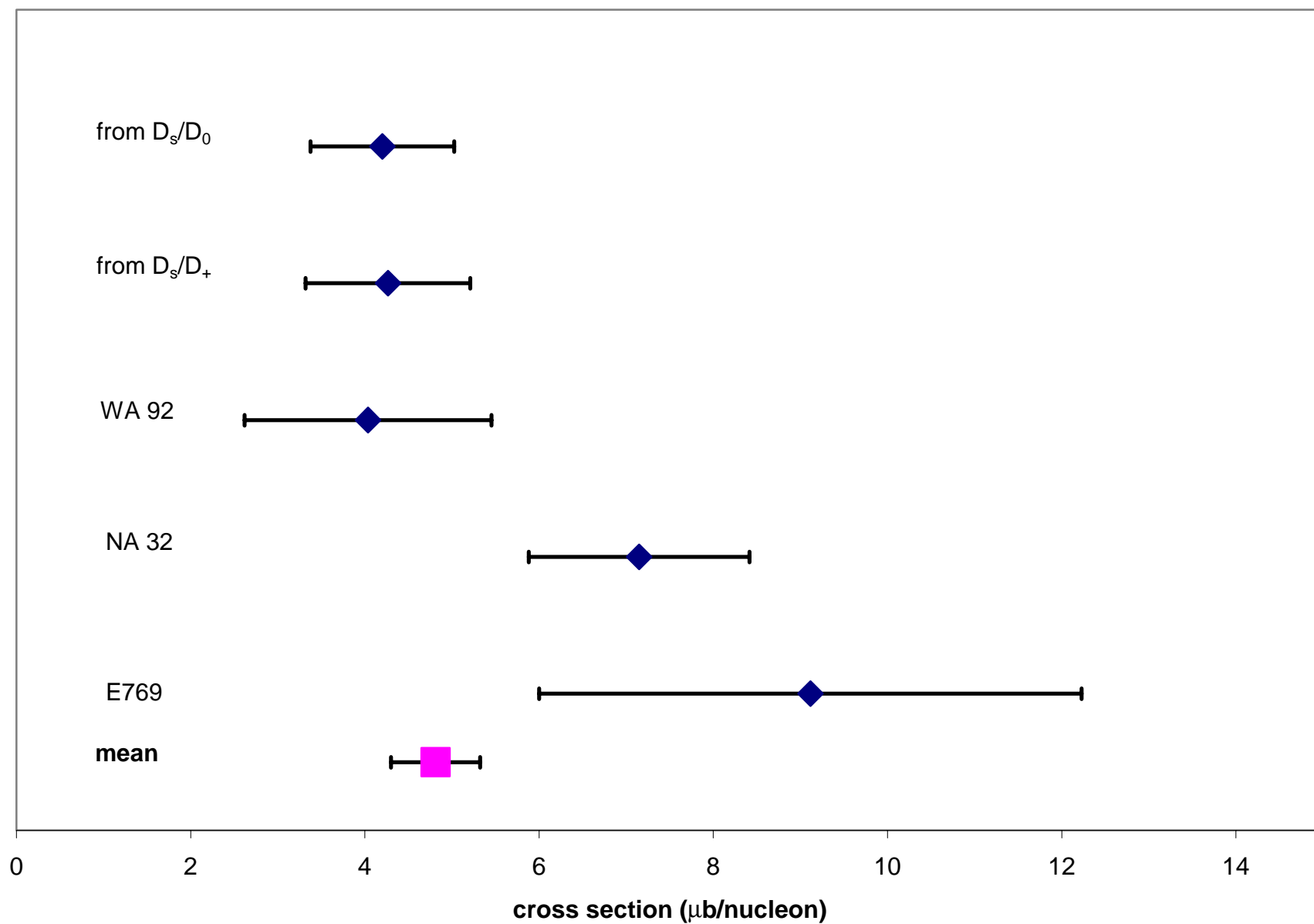
# $D_s$ production cross section for protons in fixed target experiments



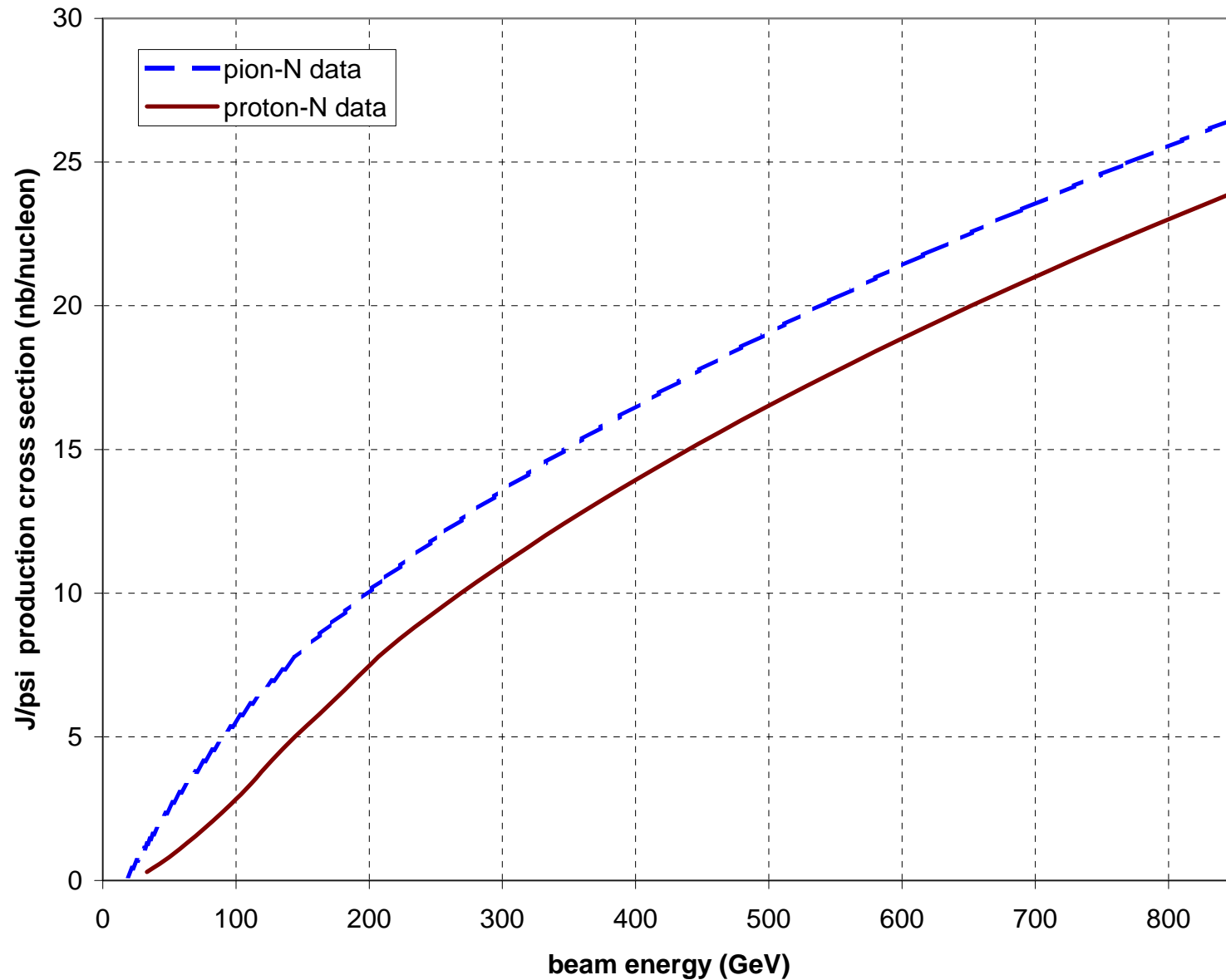
# $D_s$ production cross section

- Problem: the two ratios predict different values
- Cause for the uncertainty: the absolute  $D^\pm$  and  $D_0$  production cross sections for protons
  - is higher than theory for  $D^\pm$  and
  - lower than theory for  $D^0$  (but much closer)
- to find an answer:
  - compare to  $\pi N$  data
    - also pN versus  $\pi N$  production of  $J/\Psi$
    - also pN versus  $\pi N$  production of b mesons (factor of 0.9)
  - compare  $D_s/D^\pm$  ratio ( $\approx 0.4$ ) to  $K^\pm/\pi^\pm$  ratio ( $\approx 0.1$ )
    - $K^\pm/\pi^\pm$  ratio corrected for  $D^\pm/D^0$  ratio:  $\approx 0.25$

# $D_s$ production cross section for pions in fixed target experiments



# $J/\Psi$ production cross section for pions and protons in fixed target experiments



# Results

- The different methods to compute the  $D_s$  production cross section agree within  $2\sigma$ 
  - the smallest error comes from the  $D_s/D^0$  cross section ratio
  - the  $D^\pm/D^0$  cross section ratio for protons is very uncertain and the average does not agree with theory, pion data, kaon data,  $\gamma$  data or  $e^+e^-$  data (CLEO)
    - The  $D^\pm$  production cross section for protons seems to be too large
    - The  $D^0$  production cross section for protons seems to be too small

## Results (continued)

- The  $D_s/D^0$  production cross section for protons agrees with the pion data
- bottom and  $J/\Psi$  production indicates that the production cross section should be slightly smaller for protons than for pions.
- the  $K^\pm/\pi^\pm$  ratio points to the lower value for the production cross section

# Conclusion and Outlook

- The  $D_s$  production cross section is  $(4.2 \pm 0.6) \mu\text{b}/\text{nucleon}$ .
- The error is small but the uncertainty is large
  - due to the uncertainty in the theoretical predictions
  - due to large errors and inconsistencies in measurements
- We should continue this discussion